INDOOR AIR QUALITY ASSESSMENT

Berkshire Community College
Field Administration Center
1350 West Street
Pittsfield, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment

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Background/Introduction

At the request of Mr. Shaun Buckler, Dean of Administration and Finance at Berkshire Community College, the Bureau of Environmental Health Assessment (BEHA) was asked to provide assistance and consultation regarding indoor air quality issues and health concerns at the Field Administrative Center at Berkshire Community College, 1350 West Street, Pittsfield, Massachusetts.

On July 12, 2002, a visit was made to this building by Mr. Michael Feeney, Director, Emergency Response/Indoor Air Quality (ER/IAQ) Program, BEHA, to conduct an indoor air quality assessment. Mr. Feeney was accompanied Ms. Rachel Birch of the College's Administration and Finance Office.

The building is part of a multi-level complex of campus buildings that are interconnected by walkways. The complex includes the following buildings: Susan B. Anthony Center, Field Administration Center, Jonathan Edwards Library and Koussevitzky Arts Center (KAC) (see Map 1). The Field Administration Center (FAC) is the subject of this report.

The FAC is a cement slab building constructed in 1971. A new rubber membrane roof was installed in 1997. The first and second floors contain private offices, college administration offices, classrooms, mailroom and open lounge areas. Windows are openable throughout the FAC. Offices and hallways are carpeted, with the exception of the first floor foyer.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

The FAC has a faculty and staff population of over 40. The tests were taken during normal operations at the FAC. Test results appear in Tables 1-5.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 ppm in two of forty-four areas surveyed, indicating an adequate air exchange in the majority of areas sampled. Please note that many areas were not populated during the assessment and that windows were open in some areas. Both of these conditions can reduce carbon dioxide levels in a building.

Fresh air in classrooms and offices with multiple occupants are equipped with a unit ventilator (univent) system (see Picture 1). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building and return air through an air intake located at the base of each unit (see Figure 1). Fresh air and return air are mixed, filtered, heated and provided to classrooms and offices through a fresh air diffuser located in the top of the unit. Desks and other items were blocking return vents in some areas. Blockage of return vents as well as holes in the floor and wall of univent cabinets can result in increased draw of fresh air from outdoors. In order for univents to function as designed, univents must remain free of obstructions.

The mechanical exhaust ventilation system consists of ceiling and wall-mounted exhaust vents. These vents are connected to exhaust fans on the roof. Exhaust vents were drawing weakly in some areas.

The building does not have a mechanical heating, ventilating and air conditioning (HVAC) system for private offices. Wall-mounted radiators provide heat in these areas. Fresh air is supplied by opening windows. In an effort to provide air movement in some offices, fans were installed in interior adjoining walls (see Picture 2). A number of areas on the second floor have been subdivided into offices and other space. Of note is the new mailbox room (see Picture 3), which has a univent that originally supplied fresh air for a large open study area. A wall was erected to form the mailroom and a corridor leading to the walkway to the KAC. A passive door vent was installed in an attempt to provide exhaust ventilation via grilles located in the wall between the second floor restrooms. This installation results in the degradation of airflow through this section of the building.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room for offices 15 cfm for classrooms (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix I.

Temperature measurements ranged from 75° F to 79° F, which were very close to the BEHA recommended comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. It is difficult to control temperature and maintain comfort in a building without operating the HVAC equipment as designed. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 33 to 41 percent, which was below the BEHA recommended comfort range in most areas. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity.

Of note is that relative humidity measured indoors exceeded outdoor measurements (range +1-8 percent). The increase in relative humidity can indicate that the exhaust system is not operating sufficiently to remove normal indoor air pollutants (e.g., water vapor from respiration) or that no mechanical means of exhaust ventilation exists. Moisture removal is important since the sensation of heat conditions increase as relative humidity increases. As indoor temperatures rise, the addition of more relative humidity will make occupants feel hotter. If moisture is removed, the comfort of individuals is increased. Removal of moisture from the air, however, can have some negative effects. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

A significant musty odor was detected in the hallway connecting the FAC and Koussevitzky Arts Center (KAC). BEHA staff detected the odor centered around the new mailroom, previously described in the ventilation section of this assessment. College officials reported that carpeting in this area was installed several weeks prior to the BEHA visit. During the period of time that had passed between the carpet installation and date of assessment was a stretch of excessively humid weather in Massachusetts, producing an outdoor relative humidity at various times from 73 percent to 100 percent without precipitation from July 4, 2002 through July 12, 2002 (The Weather Underground, 2002). According the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE), if relative humidity exceeds 70 percent, mold growth may occur due to wetting of building materials (ASHRAE, 1989).

The univent was operating in this area during the assessment. During the normal operation of the univent, moisture is introduced into a building during weather with high relative humidity. As relative humidity levels increase indoors, porous building materials, such carpeting can absorb moisture. The moisture content in carpet can fluctuate with increases/decreases in indoor relative humidity and temperature. Therefore, it is important that moist outdoor air introduced by the univent be vented from the building by a mechanical exhaust system. As noted previously, the erection of the dividing wall and installation of a door vent inhibits the free flow of air from the new mailroom. Moist air pools within this area, which can subsequently moisten carpet for extended periods of time. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 hours of becoming wet (ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Once mold growth has occurred, disinfection of some materials may be possible, however since carpeting is a porous surface, disinfection is likely to be ineffective.

A similar, but less pungent odor was detected in the old mailroom during the assessment. The configuration is similar, in that walls with a passive vent were erected (see Picture 4) to create the enclosed space. However, an exhaust vent exists within this work area, with the univent operating in the foyer.

College officials reported that the second floor of the building experienced significant roof leaks, which were corrected with the installation of the new roof. Of interest is the condition of acoustic tile adhered to the ceiling. The ceiling system consists of a cement honeycomb design (see Picture 5). At the top of each honeycomb chamber is an acoustic ceiling tile, which seems to be directly adhered to the cement. A number of areas have tiles that appear to be water-damaged (see Picture 6). Replacement of these tiles is difficult, since their removal would likely cause the destruction of the tile, which can result in the aerosolization of particulates. Water-damaged ceiling tiles may provide a medium for mold growth and should be replaced after a water leak is discovered.

Of note is the design of the building. Offices along the northern face of the FAC were built on a cement slab that extends several feet horizontally from the window system to form a ledge (see Picture 7). The exterior wall on each slab is formed by a combination metal frame/spandrel/glass window/wall system. The seams between the wall system and cement slab appear to be sealed with new caulking (possibly during the installation of new roof). This design allows rainwater and snow to collect on the horizontal surface and pool/drift against the exterior wall. This may have resulted in water penetration into the interior of offices through fissures and cracks in exterior walls. Some seams in caulking were observed which can serve as pathways for water penetration into the wall system. In addition, seams within the metal frame/spandrel/glass window/wall system were not sealed. If spaces exist in this wall system, water may penetrate into the interior.

Several areas contained a number of plants. Plant soil, standing water and drip pans can be potential sources of mold growth. Drip pans should be inspected periodically for mold growth and over-watering should be avoided. Plants should also be located away from univents to prevent aerosolization of dirt, pollen or mold.

Other Concerns

The second floor women's restroom floor drain appeared to be dry. Underused drains, if not properly wetted or sealed, can dry out and lead to sewer gas back up into adjacent areas/offices.

A crawlspace exists beneath the first floor, with an opening along the north wall (see Pictures 8 and 8A). Several openings to the crawl space on the first floor may exist, which would include heating pipes for univents and radiators; electrical circuit breaker box wire holes (see Pictures 9 and 9A); and the telephone service box (see Pictures 10 and 10A). Each of these can provide pathways for crawlspace air to penetrate into occupied areas. In order to explain how crawlspace pollutants may be impacting above areas, the following concepts concerning heated air and creation of air movement must be understood:

- o Heated air will create upward air movement (called the stack effect).
- o Cold air moves to hot air, which creates drafts.
- o As heated air rises, negative pressure is created, which draws cold air to the equipment creating heat (e.g., steam pipes).
- o The operation of HVAC systems (including rest room exhaust vents) can create negative air pressure, which can draw air and pollutants from the crawlspace.

If these conditions are present, it is possible that crawlspace air can be drawn into occupied spaces through breeches in the crawlspace ceiling/floor. The location of the entrance can potentially aid the transfer of air from the crawlspace into occupied space. The crawlspace openings are located on the northern wall, which are open to the outdoors (see Picture 9). As winds strike the building, the receded wall system can act in a manner to direct cold air into the crawlspace pressurizing this area. Transfer of air from the crawlspace and wall interiors into occupied areas should be prevented.

The old mailroom contains a number of electrical devices (computer, mail machine, photocopier, etc.). This room does not have a fresh air supply, but rather draws air through a passive vent (see Picture 4) from the hallway. In an effort to provide air circulation, a number of portable fans are stationed around the room. A local exhaust vent located on an interior wall was partially blocked with a plastic bag (see Picture 12). Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). Without proper mechanical exhaust ventilation, waste heat and pollutants produced by office equipment can build up and lead to indoor air quality/comfort complaints.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Remove the carpet from the new mailbox room.
2. Consider removing the carpet from the old mailroom.
3. Seal wall and pipe floor holes associated with the heating and ventilation system, as needed.
4. Seal wall holes around telephone wires and electrical circuit breaker box.
5. Remove all blockages from univents and exhaust vents to ensure adequate airflow.
6. Under current conditions, openable windows and doors are the only source of ventilation within many offices. Long-term solutions are advisable (see below). Use of openable windows to provide fresh air in the interim should be done in a manner to prevent damage to the heating system from freezing pipes.
7. Examine each univent for function. Survey areas for univent function to ascertain if an adequate air supply exists for each room. Operate univents while areas are occupied. Check fresh air intakes for repair and increase the percentage of fresh air intake if necessary.

8. Examine exhaust ventilation for function. Improve air draw of exhaust vents on the second floor. Repair motors if necessary and operate exhaust system during occupancy.
9. Examine the sealant in the window system on the north facing walls. Repair missing or damaged sealant as needed.
10. Remove the door to the mailbox room to improve air circulation in this area.
11. Once both the fresh air supply and the exhaust ventilation are functioning, the ventilation system should be balanced by an HVAC engineering firm.
12. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, implementation of scrupulous cleaning practices should be implemented. This will minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Use of vacuum cleaning equipment outfitted with a high efficiency particulate arrestance (HEPA) filter is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
13. Move plants away from univents and radiators. Examine drip pans for mold growth and disinfect with an appropriate antimicrobial where necessary. Consider reducing the number of plants in certain areas.
14. Wet traps of floor drains at least once a week or properly seal abandoned drains to prevent the back up of sewer gas.

The following **long-term measures** should be considered:

1. Water-damaged ceiling tiles should be replaced. These ceiling tiles can be a source of microbial growth and should be removed. Source of water leaks (e.g., window frames and roof) should be identified and repaired. Examine the non-porous surface beneath the removed ceiling tiles and disinfect with an appropriate antimicrobial.
2. Examine the feasibility of installing an HVAC system to service all occupied areas of the FAC.
3. Examine the feasibility of installing a sloped system to prevent snow and rain accumulation on the north-facing wall system.
4. Consider installing an exhaust vent fan on one of the openings to the crawlspace to depressurize this area and prevent/limit air movement to occupied areas.

References

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Picture 1

Return Vent

Univent, Note Box Blocking Return Vent and Plant Near Fresh Air Diffuser

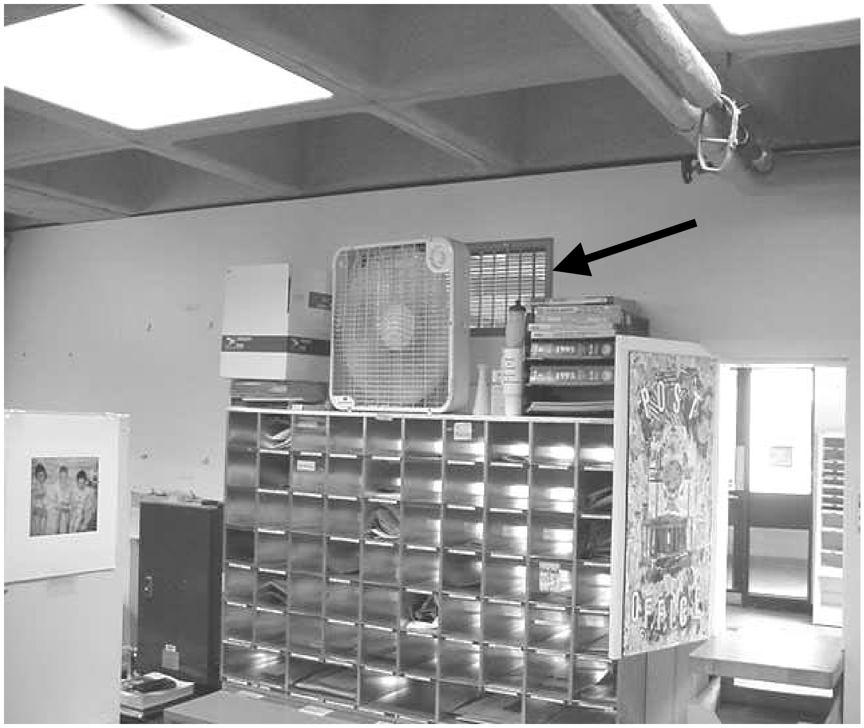
Picture 2

Fan Retrofitted into Adjoining Wall

Picture 3

Passive Door Vent of New Mailroom

Picture 4

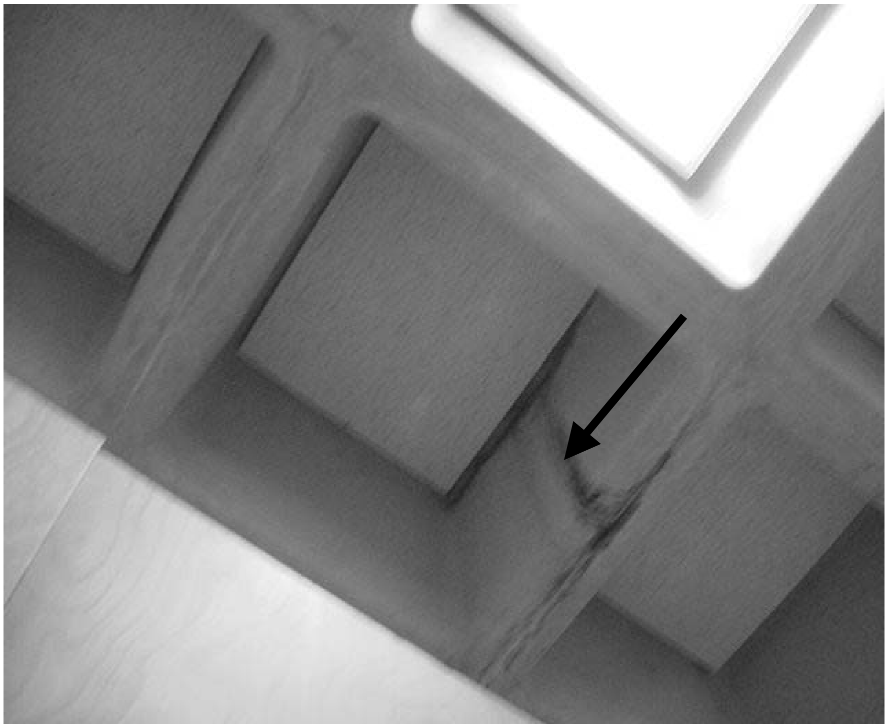


Passive Vent in Old Mailroom

Picture 5

Cement Honeycomb Ceiling

Picture 6



Honeycomb Ceiling System with Ceiling Tile Adhered To Cement, Note Water Stain

Picture 7

Ledges on The North side of The FAC

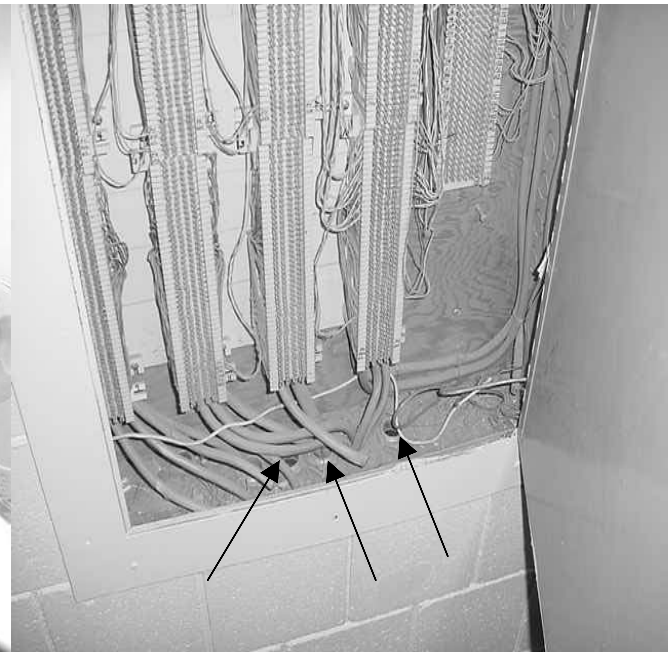
Pictures 8 and 8A

Outdoor Openings to Crawlspace

Picture 9 and 9A

The Circuit Breaker Box, Note Dust and Holes in Is Base

Pictures 10 and 10A

The Telephone Service Box, Note Hole In Its Base

Picture 11

Exhaust Vent Partially Blocked by Plastic Bag In Mailroom

TABLE 1

Indoor Air Test Results
Pittsfield, Berkshire Community College Field Administration Center July 12, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	390-401	75-76	33-34					Clear, sunny
224	540	76	37	1	Y	N	N	Door open
FC 210	571	76	37	0	N	N	N	Door open
226	507	75	37	0	Y	N	N	Planter, door open, window open
227	512	75	37	21	Y	N	N	Tar odor-paving of sidewalk, door & window open
228	475	75	36	1	Y	N	N	Tar odor-paving of sidewalk, window open
229	469	75	37	0	Y	N	N	Door open
231	437	75	36	0	Y	N	N	Fax, laser jet printer, door open, ceiling fan – on, window open
232	433	75	37	1	Y	N	N	Ceiling fan – on, window open
FC 213	459	76	38	0	N	N	Y	Ceiling fan - off

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results
Pittsfield, Berkshire Community College Field Administration Center July 12, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
FC 212	467	76	39	0	N	N	N	WD ceiling materials
FC 208	638	79	36	1	N	Y	Y	Passive supply vent, odor, 3 fans, door open
Mail Room	441	78	33	0	Y	N	N	Odor, window open
216	423	78	35	0	Y	Y	Y	Passive vent
215	598	77	39	0	N	N	N	Plants
214	571	77	37	0	N	N	N	Plants
213	483	77	37	0	N	N	N	
212	573	77	37	1	N	N	N	Door open
211	493	77	37	0	N	N	N	
210	504	77	37	0	N	N	N	Plants

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TABLE 3

Indoor Air Test Results
Pittsfield, Berkshire Community College Field Administration Center July 12, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
209	548	77	37	0	N	N	N	Plants
208	485	77	39	1	N	N	N	
207	465	77	39	0	N	N	N	Plants, window open
206	468	77	37	1	N	N	N	
205	470	78	37	0	N	N	N	Odor
204	649	79	38	0	N	N	N	WD-ceiling (old leak), hole in wall, plants, door open
Woman's RR						Y	Y	Passive vent
203	441	79	37	0	Y	Y	Y	WD acoustical tile, carpet
202	440	77	36	0	Y	Y	Y	
New Mail Room	416	78	35	0	Y	Y	N	Door vent, strong mold odors, window open

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Comfort Guidelines

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Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results
Pittsfield, Berkshire Community College Field Administration Center July 12, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
117	484	76	37	2	Y	N	N	Window open
116	580	75	40	0	Y	N	N	Ceiling fan-on
115	661	76	40	1	Y	N	N	Ceiling fan
114	545	76	39	0	Y	N	N	Ceiling fan, window open
113	560	76	39	0	Y		N	Ceiling fan-off
112	581	76	40	0	Y	N	N	
111	540	76	38	2	Y	Y	Y	Door open, window open
110	528	76	39	0	Y	Y	Y	Photocopier, Door open
108	678	77	38	1	Y	N	N	Photocopier, Door open
126	1065	77	41	2	Y	N	N	Ceiling fan-on

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Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
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Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 5

Indoor Air Test Results
Pittsfield, Berkshire Community College Field Administration Center July 12, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
125	1022	77	41	1	Y	N	N	Ceiling fan on, door open
124	499	76	37	0	Y	N	N	
123	493	76	37	0	Y	N	N	Door open
122	484	76	36	2	Y	N	N	
121	477	75	35	1	Y	N	N	Window open
1st Floor Foyer	497	76	36	0	Y	N	N	

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Comfort Guidelines

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Temperature -	70 - 78 °F
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